# Dialysis and complications in ED

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- Sixty years ago, Belding Scribner and his colleagues at the University of Washington developed a blood-access device using Teflon-coated plastic tubes, which facilitated the use of repeated hemodialysis as a life-sus-taining treatment for patients with uremia.
- The introduction of the Scribner shunt, soon led to the development of a variety of surgical techniques for the creation of arteriovenous fistulas and grafts.
- hemodialysis has made survival possible for more than a million people throughout the world who have end-stage renal disease (ESRD) with limited or no kidney function.
- The expansion of dialysis into a form of long-term renal-replacement therapy transformed the field of nephrology and also created a new area of medical science, which has been called the physiology of the artificial kidney.

- The two major dialysis modalities are hemodialysis and peritoneal dialysis.
- Each is based on a technique whereby the patient’s blood comes into contact with a semipermeable membrane on the other side of which is a specially constituted balanced physiologic solution.

- Hemodialysis requires special access to the patient’s circulation, generally through a surgically created arteriovenous fistula or implanted artificial graft, or a surgically placed tunneled catheter.

- In peritoneal dialysis, the patient's peritoneum functions as the dialysis membrane.
- Dialysate is infused through a surgically implanted Silastic catheter (Tenckhoff catheter) that penetrates the lower abdominal wall.
- Fluid exchanges are performed several times per day, typically by the patient at home.
- As compared with hemodialysis, peritoneal dialysis offers:
- the advantages of greater patient independence, avoidance of anticoagulation, and
- smoother control of volume and hypertension.

- The main disadvantage of peritoneal dialysis is a significant incidence of bacterial peritonitis, which is, however, usually readily treatable.

# Indications for Dialysis

- The decision to initiate chronic dialysis in the patient with CKD generally is made by the patient's nephrologist.
- The absolute value of the BUN or serum creatinine generally is used only as a rough guide to when chronic dialysis should be instituted.

- For patients who come to the ED with AKI, and CKD , it is the **emergency physician** who must be prepared to make the decision to arrange for dialysis to be provided emergently

- The most common problem requiring emergent dialysis, particularly in CKD, is pulmonary edema secondary to volume overload.
- In general, the cause is over ingestion of fluid and salt.
- many of these patients require immediate dialysis.

- A related problem that may require emergent, or at least urgent, dialysis is hypertension, when associated with hypertensive encephalopathy or cardiovascular decompensation.
- hypertension in most patients with renal failure commonly is volume dependent, correction of volume overload, even if it is clinically not apparent, is a central component of therapy.

- Temporizing measures such as the administration of intravenous sodium nitroprusside or nitroglycerin often permit hypertension to be controlled sufficiently for dialysis to be delayed for several hours.
- prolonged administration of sodium nitroprusside carries an increased risk of thiocyanate toxicity in patients with renal failure.

- In many cases, hypertension and associated symptoms are difficult to control until dialysis permits volume overload to be corrected.
- the blood pressure often is dramatically responsive to reduction of circulating volume.

- Severe hyperkalemia is another common indication for emergent or urgent dialysis, in AKI.
- In CKD, hyperkalemia usually is caused by excessive potassium intake, but endogenous causes such as hemolysis or rhabdomyolysis should be kept in mind as well.

- The available temporizing measures can be used with variable degrees of effectiveness, but dialysis remains the most effective technique of removing potassium from the body.
- For rapid control of the serum potassium, hemodialysis, with its high clearance rates, is preferred to peritoneal dialysis.

- Severe metabolic acidosis in the setting of renal failure is another indication for emergent dialysis, if volume overload precludes the administration of reasonable amounts of bicarbonate.

- A somewhat unusual situation is one in a patient with renal failure who has taken an overdose or been administered medication that is cleared by kidneys.
- If the agent is dialyzable and its continued presence in the circulation is a significant risk to the patient, immediate dialysis can be lifesaving.
- An example of such a situation is ingestion of methanol or ethylene glycol by a dialysis patient.

- The serum creatinine and BUN levels are not considered definitive indications for dialysis. A creatinine of 10 mg/dL or a BUN of 100 mg/dL often is used as a guideline for beginning chronic dialysis in progressive renal failure.
- In dialyzed patients, serum creatinine often is greater  than 10 mg/dL but is a reflection of total body muscle mass than the adequacy of dialysis.

- The BUN is a somewhat better indicator;
- the level in well-dialyzed persons generally is in the range of 50 to 80 mg/dL and
- is more than 100 mg/dL in less well-dialyzed patients.

- uremic symptoms or signs such as nausea,  vomiting, lethargy, or twitching indicates a need for dialysis but does not necessitate immediate initiation of dialysis unless symptoms are severe.
- Pericarditis, even in the absence of cardiac tamponade, often is considered an indication for urgent dialysis.

- In an undialyzed patient with progressive renal insufficiency, appearance of pericarditis indicates that it is time to initiate dialysis.

# *Complications of Hemodialysis*

## Vascular Access–Related Complications

- The performance of hemodialysis depends on reliable vascular access, and it is the vascular access device that is responsible for complications of dialysis that most often require evaluation in the ED setting.

- Bleeding from the dialysis puncture site can occur hours after a hemodialysis treatment, either spontaneously or after a minor trauma to the site.
- bleeding almost always can be stopped by applying firm pressure to the access site.
- the presence of a thrill immediately must be evaluated after compression.
- It may be necessary to keep the patient in the ED for a time to ensure that bleeding does not recur.

- if the patient reports that the thrill in the access has been lost, a vascular surgeon should be consulted immediately.
- Although thrombolytic agents sometimes are used, definitive treatment generally is surgical revision.

- Infection of the vascular access is not uncommon and can result in persistent or recurrent bacteremia.
- Infection appears to be a consequence of contamination at the time of puncture for dialysis; most infections are caused by staphylococci typical of skin flora.

- it is common practice to obtain blood cultures for all patients on hemodialysis who have a fever without an obvious source of infection and to treat them for an access infection.
- A careful search for other sources of infection is done, before nonapparent access infection is concluded to be the cause.

- some nephrologists prefer to admit all dialysis patients with fever to the hospital.
- management of these patients on an outpatient basis often is possible.

- This course is made more practicable by the fact that they can be loaded with intravenous antibiotics that dependably maintain adequate blood levels until the time of the next scheduled dialysis treatment.

- Vancomycin 1 to 1.5 g given IV as a single loading dose is the drug of choice in this situation because most access infections are staphylococcal and because this drug is only minimally hemodialyzable and needs to be given only every 5 to 7 days in the chronic dialysis patient.
- If a gram-negative infection also is thought to be likely, as in a patient who has had recent episodes of gram-negative bacteremia, a loading dose of a second drug (e.g., a third-generation cephalosporin or an aminoglycoside) also can be administered.
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# Non–Vascular Access–Related Complications

- *The hemodialysis procedure itself, includes invasion of the vasculature,*
- *anticoagulation, and*
- *significant shifts of fluid and solutes.*
- *These are often associated with acute complications such as :*
- *hypotension, shortness of breath, chest pain, and neurologic abnormalities.*

# *Hypotension*

- Hypotension that occurs after dialysis most commonly is the result of an acute reduction in intravascular volume.
- Because hemodialysis is episodic, each treatment must remove the excess fluid that has accumulated over the period since the last dialysis.

- With rapid removal of extracellular fluid, there is inadequate  time for transcellular fluid shifts to replace intravascular volume.

- Most episodes of hypotension that occur during hemodialysis will resolve spontaneously
- or can be readily managed by a decrease in blood flow rate or the infusion of small volumes of saline .
- Patients with significant hypotension who do not respond to these maneuvers often are brought to the ED for further evaluation.
- Patients on dialysis should be considered to be at risk for acute myocardial infarction, acute dysrhythmias, and sepsis. These are common causes of hypotension among all patients in the ED, and consideration should first be given to these entities

- patients typically have low baseline hemoglobin levels, and acute blood loss may result in symptomatic angina or CHF.
- Serum levels of clotting factors are normal in CKD, but patients are routinely anticoagulated for each hemodialysis treatment.
- Bleeding is also a possible risk in dialysis patients

- Overt bleeding from the GI tract, often caused by angiodysplasia or peptic ulcer disease, is common and can be dramatic.

- acute hypotension may be caused by anaphylaxis or an anaphylactoid reaction to some component of the dialyzer or the dialysate;.
- Acute pulmonary embolism and acute air embolism are two less likely possibilities.

- Two additional entities in the differential diagnosis for hypotension are acute pericardial tamponade and severe, life-threatening hyperkalemia.
- Acute pericardial tamponade may be the result of sudden pericardial hemorrhage or sudden worsening of a formerly existing pericardial effusion.

- Ultrasonographic demonstration of right ventricular diastolic collapse is more specific, but a definitive diagnosis of tamponade depends on the direct demonstration of equal pressures in the right and left atria on cardiac catheterization.

- Emergency pericardiocentesis must occasionally be performed in the ED to relieve acute tamponade.
- Similarly, in the case of a dialysis patient who is in cardiac arrest, pericardiocentesis generally should be attempted if initial resuscitative efforts have not been successful.

- Patients who are hyperkalemic can have profoundly slow heart rates, particularly if they have been treated with beta-blockers or calcium channel blockers.
- If a dialysis patient is in cardiac arrest, it should be assumed that hyperkalemia is present, and intravenous calcium should be given immediately.

# *Shortness of Breath*

- Shortness of breath in dialysis patients generally is caused by volume overload.
- Also other causes must be sought— primarily sudden cardiac failure, pericardial tamponade, pleural effusion, or pleural hemorrhage.
- Air embolism and anaphylactoid reactions are unusual causes. Often, pneumonia or underlying reactive airway disease is responsible.

# *Chest Pain*

- Chest pain during dialysis must be taken seriously because cardiovascular disease is a leading cause of death in patients  with CKD.

- In addition, dialysis patients may be anemic, and many are chronically  volume-overloaded.

- renal failure associated electrolyte and acid-base disturbances does not in general mimic, usual ECG changes of angina or acute myocardial infarction.
- The pattern of the change of serum cardiac enzymes with acute infarction also is not altered by CKD, although the baseline level of these enzymes may be higher than in the general population. Troponin appears to perform best as a marker of infarction in patients with CKD.

- Treatment of ischemic chest pain is the same as for other populations.

# *Neurologic Dysfunction*

- Neurologic dysfunction manifesting during or after hemodialysis often is caused by disequilibrium syndrome,
- This is a result of rapid changes in body fluid composition and osmolality during hemodialysis.
- It usually occurs only in patients with high BUN levels who are just starting hemodialysis.
- The syndrome does not occur with peritoneal dialysis.

- It is dangerous, to attribute an altered mental status to disequilibrium syndrome unless other potential causes have been ruled out.

- In particular, the finding of any new focal neurologic abnormality calls for, at a minimum, an immediate head CT scan to detect intracranial hemorrhage.

# Complications of Peritoneal Dialysis

- As with hemodialysis, most of the complications of peritoneal dialysis are related to the dialysis access device, in this case the peritoneal catheter.

- Peritonitis is the most common complication of peritoneal dialysis.
- it is in general much less severe than other types of peritonitis

- Peritonitis in patients on peritoneal dialysis is caused by bacterial contamination of the dialysate  or tubing during an exchange, or by extension of an infection of the exit site or the subcutaneous tunnel into the peritoneal cavity.

- A majority of cases of peritonitis are caused by *Staphylococcus aureus or Staphylococcus epidermidis, and most of the remainder* (approximately 30%) by gram-negative enteric organisms.
- No organism in 10 to 20% of cases of peritoneal dialysis–associated peritonitis.

- The diagnosis of peritonitis is commonly made by the patient when a cloudy dialysis effluent is noted.
- Even in the absence of cloudy fluid, when a patient has fever or abdominal symptoms, it is advisable to consider peritonitis and to check the fluid.

- In the ED setting the diagnosis of peritonitis is confirmed by the finding of more than 100 WBCs/mm3 in the peritoneal fluid, with more than 50% neutrophils, or by a positive result on Gram staining.

- Peritoneal dialysis–associated peritonitis is treated with an initial intraperitoneal loading dose of antibiotic, followed by a 10- to 14-day course of intraperitoneal antibiotics

- A common treatment regimen is a loading dose of vancomycin 30 mg/kg given IP, followed by further intraperitoneal doses every 5 to 7 days, plus ceftazidime or cefepime 1 g IP or gentamicin 0.6 mg/kg IP.
- Heparin 500 to 1000 units also may be added to each bag of dialysate for the first few days of treatment to help reduce the formation of fibrin strands.

- Patients who have severe abdominal pain, vomiting, ileus,  chills or high fever, or hypotension require hospital admission  and management.

- The manifestations of serious disorders unrelated to dialysis (e.g., acute appendicitis, diverticulitis, cholecystitis, acute pancreatitis, ischemic bowel, perforated viscus) also may be attributed to ordinary peritoneal dialysis–associated peritonitis, with the potential for disastrous consequences.

- Patients on peritoneal dialysis also may come to the ED with any of several basically mechanical problems, of which the most common is failure of the dialysate to drain completely at the time of an exchange.
- this problem is caused simply by kinking or clamping of the external catheter or tubing.
- More often, it is the result of catheter obstruction by fibrinous debris.

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